Title: A solid oral tooth whitening composition

Technical Field

The invention relates to solid, oral tooth whitening compositions. The invention further relates to the use of such compositions to whiten tooth surfaces.

Background Art

Tooth whitening or stain removing agents are known to be added to dentifrice compositions such as toothpaste, mouthwash, chewing gum, confectionary compositions and the like. The use of such compositions for reducing stains and discolouration of tooth surfaces thereby improving the general cosmetic appearance of the teeth is likewise well-known. Teeth with extrinsic stains are objectionable both on the basis of cosmetic appearance and also socially as indication of poor oral hygiene.

Some products contain peroxides, but these are, however, problematic from a toxicological point of view. Another approach to tooth whitening products is to add abrasives - known mainly from dentifrices. Not all of these are legal in confectionary.

Several abrasive agents have been used for tooth whitening purposes and these are known to the person skilled in the art. Examples of abrasive agents include calcium carbonate, sodium bicarbonate, sodium metaphosphate, potassium metaphosphate, tricalcium phosphate, dihydrated dicalcium phosphate, bentonite, zirconium silicate

or other siliceous materials. Other suitable abrasives are described in U.S. Patent No. 4,170,633 and U.S. Patent No. 4,891,211, incorporated herein by reference.

Several patents and patent applications disclose the use of abrasive materials in solid, oral compositions, see for example U.S. Patent Nos. 5,147,632 and 5,496,541, EP Patent No. 372,603, International Publication Nos. WO 02/19834 and WO 01/56399.

US Patent Application US 2002/0142068 discloses chewing gum formulations including sodium pyrophosphate and encapsulated aspartame.

US Patent No. 4,233,288 discloses a gum emulsified liquid composition for delivering and preserving the liquid content in the mouth. The herein disclosed examples describe a gum emulsified liquid composition comprising 5% of calcium pyrophosphate and more than 50% of liquid components.

U.S. Patent No. 3,590,120 discloses a chewing gum comprising a polishing agent comprising a mixture of fine and coarse zirconium silicate particles. Disclosed herein are reference chewing gum compositions containing 10% of calcium pyrophosphate or 10% of calcium carbonate, respectively. The cleaning/polishing effects of said compositions are shown to decrease in the order $ZrSiO_4$, $CaCO_3$ and CaP_2O_7. Indicative studies have however shown some problematic toxicological properties of zirconium silicate (Elmore AR, Cosmetic Ingredient Review Expert Panel, Final report on the safety assessment of aluminum silicate, calcium silicate, magnesium aluminium silicate, magnesium silicate, magnesium trisilicate, sodium

aluminium silicate, magnesium silicate, magnesium trisilicate, sodium magnesium silicate, zirconium silicate, attapulgite, bentonite, Fuller's earth, hectorite, kaolin, lithium magnesium silicate, lithium magnesium sodium silicate, montmorillonite, pyrophyllite, and zeolite, Int. J Toxicol. 2003; 22 Suppl. 1:37-102) and the use of zirconium compounds in solid oral compositions is prohibited in a number of countries.

Thus, a need exists in the art to identify and use abrasives in a solid, oral tooth whitening composition to obtain an increased whitening effect.

Disclosure of Invention

The present invention relates to a solid, oral tooth whitening composition comprising more than 75% by weight of solid materials, said composition comprising:

(a) a chewing gum or confectionary base,

(b) conventional chewing gum or confectionary additives,

(c) a tooth whitening agent comprising calcium pyrophosphate present in an amount of 0.5 to 9% by weight of the composition.

Furthermore, the present invention relates to the use of a composition according to the present invention to whiten tooth surfaces.

Furthermore, the present invention relates to a method of whitening tooth surfaces.

Brief Description of the Drawings

The invention is explained in detail below with reference to the drawing(s), in which

Fig. 1 shows the release percentage as a function of time for calcium carbonate and calcium pyrophosphate, respectively, present in a chewing gum composition.

Best Modes for Carrying out the Invention

It has now surprisingly been demonstrated, using *in vitro* tests, that improved stain removal and stain inhibition effects of solid, oral compositions can be achieved using from 0.5 to 9 % of calcium pyrophosphate as an abrasive agent, compared to the use of the often used abrasive, calcium carbonate. These effects are unexpected, seen in the light of the results presented in US 3,590,120, in which the polishing effect of CaP_2O_7 was significantly poorer than that of $CaCO_3$.

In addition to these results, it has also been surprisingly shown, using *in vivo* tests, that calcium pyrophosphate-containing chewing gum results in an improved removal of stain on tooth surfaces which do not normally come into contact with the gum while chewing, i.e. maxillary facial tooth surfaces, as well as on tooth surfaces on which stains build up rapidly and heavily and is the most difficult to remove, i.e. proximal tooth surfaces.

Typically, solid, oral tooth whitening compositions are intended to comprise a recommended daily dose of tooth whitening agent of about 40 to 700 mg. Conven-

iently, this dose may be divided into multiple sub-doses, such as 8 units of the composition, each unit weighing approximately 900-1000 mg, excluding any coating. Thus, a content of 0.5% to 9 % of tooth whitening agent corresponds to a composition unit content of approximately 4.5 to 90 mg of tooth whitening agent.

The compositions of the invention are essentially solid and comprise more than 75%, preferably more than 85%, even more preferably more than 95%, by weight of the composition of solid materials.

In a preferred embodiment of the invention, calcium pyrophosphate is present in an amount of between 3% and 8%, preferably between 4.5% and 7.5 %, even more preferably between 5.5% and 7 %, by weight of the composition, respectively, excluding any coating.

In one embodiment, the composition according to the invention may be formulated as a chewing gum composition, said chewing gum composition preferably comprising a gum base constituting from 10% to 99%, particularly from 15% to 80%, preferably 25% to 60 % by weight of the composition. As used herein the expression "gum base" refers in general to the water insoluble part of the chewing gum. Chewing gum base formulations typically comprise one or more elastomeric compounds which may be of synthetic or natural origin, one or more resin compounds which may be of synthetic or natural origin, fillers, softening compounds and minor amounts of miscellaneous ingredients such as antioxidants and colorants, etc.

In this context, useful synthetic elastomers include, but are not limited to, synthetic elastomers listed in Food and Drug Administration, CFR, Title 21, Section 172,615, the Masticatory Substances, Synthetic) such as polyisobutylene with a gas pressure chromatography (GPC) average molecular weight in the range of about 10,000 to about 1,000,000 including the range of 50,000 to 80,000, isobutylene-isoprene copolymer (butyl elastomer), styrene-butadiene copolymers e.g. having styrene-butadiene ratios of about 1:3 to about 3: 1, polyisoprene, polyethylene, vinyl acetate-vinyl laurate copolymer e.g. having a vinyl laurate content of about 5 to about 50% by weight such as 10 to 45% by weight of the copolymer, and combinations hereof.

Useful natural non-degradable elastomers include the elastomers listed in Food and Drug Administration, CFR, Title 21, Section 172,615, as "Masticatory Substances of Natural Vegetable Origin" including natural rubber compounds such as smoked or liquid latex and guayule and other natural gums including jelutong, lechi caspi, massaranduba balata, sorva, perillo, rosindinha, massaranduba chocolate, chicle, nispero, gutta hang kang, and combinations thereof. The preferred synthetic elastomer and natural elastomer concentrations vary depending on whether the chewing gum in which the base is used is adhesive or conventional, bubble gum or regular gum. Presently preferred natural elastomers include jelutong, chicle, massaranduba balata and sorva.

Resin in conventional chewing gum bases typically include synthetic resins such as poly(vinyl acetate) (PVAc) and natural resins such as rosin esters which are often referred to as ester gums. Additionally, natural resins such as glycerol esters of partially hydrogenated rosins, glycerol esters of polymerised rosins, glycerol esters of

partially dimerised rosins, glycerol esters of tally oil rosins, pentaerythritol esters of partially hydrogenated rosins, methyl esters of rosins, partially hydrogenated methyl esters of rosins and pentaerythritol esters of rosins are typically applied in chewing gum bases. Other resinous compounds typically applied in chewing gum bases include synthetic resins such as terpene resins derived from alpha-pinène, beta-pinene, and/or d-limonene and natural terpene resins.

A chewing gum base formulation may, if desired, include one or more fillers/texturisers including as examples, magnesium and calcium carbonate, sodium sulphate, ground limestone, silicate compounds such as magnesium and aluminium silicate, kaolin and clay, aluminium oxide, silicium oxide, talc, titanium oxide, mono-, di- and tri-calcium phosphates, cellulose polymers, such as wood, and combinations thereof.

A gum base formulation may, in accordance with the present invention comprise one or more softening agents e.g. sucrose polyesters including those disclosed in WO 00/25598, which is incorporated herein by reference, tallow, hydrogenated tallow, hydrogenated and partially hydrogenated vegetable oils, cocoa butter, glycerol monostearate, glycerol triacetate, lecithin, mono-, di- and triglycerides, acetylated monoglycerides, fatty acids (e.g. stearic, palmitic, oleic and linoleic acids), and combinations thereof. As used herein the term "softener" designates an ingredient, which softens the gum base or chewing gum formulation and encompasses waxes, fats, oils, emulsifiers, surfactants and solubilisers.

To soften the gum base further and to provide it with water binding properties, which confer to the gum base a pleasant smooth surface and reduce its adhesive properties, one or more emulsifiers is/are usually added to the composition, typically in an amount of 0 to 18% by weight, preferably 0 to 12% by weight of the gum base. Mono- and diglycerides of edible fatty acids, lactic acid esters and acetic acid esters of mono- and diglycerides of edible fatty acids, acetylated mono and diglycerides, sugar esters of edible fatty acids, Na-, K-, Mg- and Ca-stearates, lecithin, hydroxylated lecithin and the like are examples of conventionally used emulsifiers which can be added to the chewing gum base. In case of the presence of a biologically or pharmaceutically active ingredient as defined below, the formulation may comprise certain specific emulsifiers and/or solubilisers in order to disperse and release the active ingredient.

Waxes and fats are conventionally used for the adjustment of the consistency and for softening of the chewing gum base when preparing chewing gum bases. In connection with the present invention any conventionally used and suitable type of wax and fat may be used, such as for instance rice bran wax, polyethylene wax, petroleum wax (refined paraffin and microcrystalline wax), paraffin, bees' wax, carnauba wax, candelilla wax, cocoa butter, degreased cocoa powder and any suitable oil or fat, as e.g. completely or partially hydrogenated vegetable oils or completely or partially hydrogenated animal fats.

In one embodiment the gum base is wax-free.

Furthermore, the gum base formulation may, in accordance with the present invention, comprise colourants and whiteners such as FD&C-type dyes and lakes, fruit and vegetable extracts, titanium dioxide and combinations thereof. Further useful chewing gum base components include antioxidants, e.g. butylated hydroxytoluene (BHT), butyl hydroxyanisol (BHA), propylgallate and tocopherols, and preservatives.

The composition of chewing gum base formulations which are admixed with chewing gum additives as defined below can vary substantially depending on the particular product to be prepared and on the desired masticatory and other sensory characteristics of the final product. However, typical ranges (weight%) of the above gum base components are: 5 to 50% by weight elastomeric compounds, 5 to 55% by weight elastomer plasticizers, 0 to 50% by weight filler/texturiser, 5 to 35% by weight softener and 0 to 1 % by weight of miscellaneous ingredients such as antioxidants, colorants, etc.

Chewing gum compositions may be formulated as sticks or pellets, and may be coated with a suitable coating. Concentrations given throughout this disclosure are based on weight excluding coating unless specifically indicated.

In another embodiment, the compositions of the invention are formulated as confectionary compositions comprising a confectionary base, said confectionary base preferably comprising from 0% to 99%, particularly from 15% to 98%, preferably 30% to 97% by weight of the composition. Non-limiting examples of confectionary com-

positions according to the invention include high boiling, grained sugar confectionary, chocolate, compressed tablets, gummy confectionary and jellies.

In addition to the ingredients listed above, the compositions comprised by the present invention may also contain one or more conventional additives such as sweeteners, high intensity sweeteners, taste enhancers, flavouring agents and the like. Sweeteners, high intensity sweeteners and taste enhancers are well known to the skilled person. Non-limiting examples of sweeteners comprise sugar sweeteners including saccharides such as sucrose, dextrose, glucose, maltose, dextrins, D-tagatose, trehalose, dried invert sugar, fructose, levulose, galactose, corn syrup solids, and the like, alone or in combination. Other examples of sweeteners comprise sugarless sweeteners including polyhydric alcohols such as sorbitol, mannitol, xylitol, glycerol, hydrogenated starch hydrolysates, maltitol, isomaltitol, erythritol, lactitol and the like, alone or in combination. Sugarless sweeteners are preferred.

Preferred high intensity sweeteners include but are not limited to sucralose, aspartame, salts of acesulfame, alitame, saccharin or salts herof, neotame, cyclamic acid and salts thereof, glycyrrhizin, dihydrochalcones thaumatin, monnelin, sterioside and the like, alone or in combination.

A variety of flavours known in the art may be used, such as cinnamon, wintergreen, eucalyptus, spearmint, peppermint, menthol, anise as well as fruit flavours such as apple, pear, peach, strawberry, cherry, apricot, orange, watermelon, banana and the like; bean-derived flavours, such as coffee, cocoa and the like. Flavouring agents are

incorporated in the chewing gum formulation at a concentration of about 0.5 to about 5 % by weight and preferably 1 to 3 % by weight.

The compositions of the invention may or may not contain sugar. Sugar-free compositions, however, are preferred.

It may be advantageous to include one or more additional tooth whitening agents. Examples of such additional tooth whitening agents are well known in the art and include abrasives as well as bleaching agents. Abrasive materials comprise as non-limiting examples silica, alumina, calcium carbonate, dicalcium phosphate, hydroxyapatite, trimetaphosphates and insoluble hexametaphosphates. Bleaching agents comprise agents such as peroxy compounds, e.g. potassium peroxydiphosphate and urea-peroxid. Effervescing systems such as sodium bicarbonate, alone or in combination with citric acid as well as colour change systems may also be incorporated into compositions comprised by the present invention.

In chewable oral compositions, said additional whitening agents are usually present in between 0.01% and 10.0%, preferably between 0.1 and 2.0%, more preferably between 0.25% and 1.0% by weight of the composition, excluding any coating.

A preferred additional tooth whitening agent comprises a bicarbonate salt. In one embodiment, said bicarbonate salt comprises sodium bicarbonate in an amount of between 0.3% and 0.4% by weight of the compositions excluding any coating.

A range of active agents may be added to the compositions of the invention. Such agents may comprise one or more of the following; oral hygiene promoting agents, anti-calculus agents, anti-microbial agents, anti-inflammatory agents, desensitising agents, therapeutically active agents, remineralising agents. Non-limiting examples comprise anti-caries agents such as sodium, calcium, magnesium and stannous fluoride, amine fluorides, disodium monofluorophosphate, sodium trimetaphosphate and casein; antimicrobial agents, e.g. Triclosan, chlorhexidine, copper, zinc and stannous salts such as zinc citrate, zinc sulphate, zinc glycinate, sodium zinc citrate and stannous pyrophosphate, sanguinarine extract, metronidazole, quaternary ammonium compounds, such as cetylpyridinium chloride; bis-guanides, such as chlorhexidine digluconate, hexetidine, octenidine, alexidine; and halogenated bisphenolic compounds, such as 2,2' methylenebis-(4-chloro-6-bromophenol); anti-inflammatory agents such as ibuprofen, flurbiprofen, aspirin, indomethacin etc.; plaque acid buffers such as urea, calcium lactate, calcium glycerophosphate and strontium polyacrylates; desensitising agents, e.g. potassium citrate, potassium chloride, potassium tartrate, potassium bicarbonate, potassium oxalate, potassium nitrate and strontium salts; anti-calculus agents, e.g. hypophosphite-containing polymers, organic phosphonates and phosphocitrates etc.; gum protection agents, e.g. vegetable oils such as sunflower oil, rape seed oil, soybean oil, safflower oil; silicone oil; and hydrocarbon oil; pharmaceutically acceptable carriers, e.g. starch, sucrose, water or water/alcohol systems etc.; surfactants, such as anionic, nonionic, cationic and zwitterionic or amphoteric surfactants. Other agents which may be incorporated in the chewable compositions of the present invention are agents to counter breath malodour and include water soluble zinc salts (at least 1% soluble) particularly zinc chloride, zinc acetate,

zinc citrate and zinc gluconate.

The additives, the whitening agents and the optional active agents comprised by the present invention may be encapsulated. This may be done in order to achieve a slow release of the encapsulated agents upon entering the oral environment. For example, a longer lasting sweetening of the compounds comprised by the present invention may be achieved by encapsulating the sweetening agents. A longer release time of the whitening agents as well as any therapeutic compound may likewise be achieved.

Another advantage of encapsulating the agents comprised by the invention may be to obtain an increased stability of the agents, thus lending a longer storage life at a greater range of storage conditions to the compositions of the invention.

Any standard method giving partial or full encapsulation can be used for encapsulation. Suitable methods include, but are not limited to, spray drying, spray chilling, fluid-bed coating, and coacervation. These methods can be used individually or in any combination in a single step process or multiple step process.

Generally, compositions of high organic solubility, good film forming properties, and low water solubility, provide a suitable encapsulation. These compositions include acrylic polymers and copolymers, carboxyvinyl polymers, polyamides, polystyrene, polyvinyl acetate, polyvinyl acetate phthalate, polyvinyl pyrrolidine, and waxes.

However, only food grade materials should be used for the encapsulation. Two standard food grade coating materials, which are good formers, but not water soluble, are shellac and Zein. Others which are more water soluble, but also good film formers, are materials such as agar, alginates, a wide range of cellulose derivatives like ethyl cellulose and hydroxypropylmethyl cellulose, dextrin, gelatin and modified starches. It is also possible to use other encapsulants like acacia or maltodextrin for encapsulation.

In yet another embodiment of the invention, it may be desirable to include a supplement, such as vitamins and/or minerals in the composition according to the invention. Vitamins are preferably added in concentrations of between 10 % - 100% of the recommended daily allowance (RDA).

Especially vitamin C may be added to the compositions of the invention.

It may be desirable to include urea in the compositions of the invention. Urea may be added as a plaque acid neutralising agent. Usually urea is added to chewable compositions in between 0.15% and 25%, particularly between 0.4% and 10%, preferably between 0.8% and 5.0%, even more preferably between 1.5 % and 2.5% by weight.

In another embodiment, the present invention relates to the use of the compositions of the invention to whiten tooth surfaces and/or prevent discolouration of tooth sur-

faces. Especially, the compositions of the invention may be used to remove or prevent discolouration of teeth due to the use of tobacco-related products and/or coffee-related products.

Examples

In the following examples 1-4, the compositions are based on a standard chewing gum composition in addition to the specified ingredients. The standard chewing gum composition used herein consists essentially of the following ingredients:

Gum base	29.64%
Sweeteners	60.98%
High intensity sweeteners	0.12%
Flavours	1.80%
Buffers/stabilizer	2.28%
Softeners	0.07%
Colourants	0.35%

Example 1

The effect of chewing gum on the removal of extrinsic stains from teeth after 120 minutes

Three standard chewing gum compositions containing, by weight of the core composition, i.e. excluding coating, 4.5% of calcium carbonate, 4.5% of calcium pyrophosphate and 6.5% of calcium pyrophosphate, respectively, were assayed for the effect on the removal of extrinsic stains on tooth surfaces.

The experiments were conducted using a modification of the laboratory method de-

scribed by Stookey, GK: Burkhart, T.A: and Schemehorn, B.R; In vitro removal of stain with dentifrices, J Dent Res 61(11):1236-1239, Nov 1982, which has been shown to correlate with the cleaning/whitening properties of dentrifrices in clinical trials. The general experimental design consists of the use of a specially designed mechanical mastication device to treat stained teeth with the test chewing gums (Kleber, CJ; Schimmele RG, Putt, MS, Muhler JC: A mastication device designed for the evaluation of chewing gums, J Dent Res 60: 109-114, 1981). The amount of stain on the teeth before and after treatment is measured quantitatively using a colorimeter.

Each composition was tested on eight enamel pieces. The mean values and the standard deviations are shown in column 2 (ΔE). The maximum removal and the concomitant standard deviation are shown in column 3 (maximum ΔE). The % of the reduction of stains is shown in column 4 (Reduction).

The values in each column with the same superscript are not statistically different, while those with different superscript are different at $p<0.05$ based on ANOVA and SNK testing.

Table 1

Whitening agent	ΔE	maximum ΔE	Reduction
4.5% $CaCO_3$	3.00 (1.12^a)	27.79 (2.33^a)	10.8%^{a}
4.5% CaP_2O_7	5.71 (1.93^b)	27.04 ($2.13^{a,b}$)	21.1%^{b}
6.5% CaP_2O_7	8.05 (2.76^c)	26.18 ($2.29^{a,c}$)	30.4%^{c}

Example 2

The effect of chewing gum on the inhibition of extrinsic stain formation

The chewing gum compositions disclosed in Example 1 were assayed for the effect on the inhibition of extrinsic stain formation on tooth surfaces.

The experiments were conducted using a special laboratory method that has been developed to determine the potential of chewing gum to inhibit the formation of dental stains and maintain white teeth. This method is based on a model that is used to evaluate the tooth whitening properties of toothpastes and is predictive of findings in human clinical studies. The general experimental design consists of the use of a specially designed mechanical mastication device to treat teeth with chewing gum while they undergo a daily staining process (Kleber, CJ; Schimmele RG, Putt, MS, Muhler JC: A mastication device designed for the evaluation of chewing gums, J Dent Res 60: 109-114). The amount of stain which accumulates on the teeth is measured quantitatively using a colorimeter.

The mean values and the standard deviations are shown in column 3 (ΔE). The maximum removal value is shown in column 4 (maximum ΔE).

The values in each column with the same superscript are not statistically different, while those with different superscript are different at $p<0.05$ based on ANOVA and SNK testing.

Table 2

Treatment		Stain formation scores	
Whitening agent	Time (days)	ΔE	maximum ΔE
4.5% $CaCO_3$	7	$19.99 \pm 1.91^{a,b}$	8.9 %
4.5% CaP_2O_7	7	$17.96 \pm 2.31^{b,c}$	18.1 %
6.5% CaP_2O_7	7	16.23 ± 2.39^{c}	26.0 %
Water	7	21.94 ± 1.75^{a}	----
4.5% $CaCO_3$	10	22.99 ± 1.03^{a}	8.3 %
4.5% CaP_2O_7	10	21.63 ± 1.94^{a}	13.7 %
6.5% CaP_2O_7	10	19.38 ± 1.90^{b}	22.7 %
Water	10	25.06 ± 1.60^{c}	----
4.5% $CaCO_3$	14	24.44 ± 1.33^{a}	7.7 %
4.5% CaP_2O_7	14	22.87 ± 1.72^{a}	13.6 %
6.5% CaP_2O_7	14	20.53 ± 1.59^{b}	22.5 %
Water	14	26.48 ± 1.69^{c}	----

Example 3

The effect of tooth whitening chewing gum on stain removal

Standard chewing gum compositions were assayed for the effect on the removal of stains on tooth surfaces, said compositions containing, by weight of the core, excluding any coating, 6.5% of calcium pyrophosphate and 0.38% of sodium bicarbonate, 4.5% of calcium carbonate and 0.38% of sodium bicarbonate, 0.38% of sodium bicarbonate and a no gum control, respectively.

A group of test persons were divided into four test groups and instructed to chew 2 pieces of chewing gum compositions as specified above, 4 times per day, each for 15 minutes, and allowed one brush per day (morning) with an assigned brush and

dentrifrice. The test persons were then examined by persons skilled in the art using the modified lobene stain index (MLSI), well known to the person skilled in the art.

The results of the total MLSI scores are shown in Table 3, wherein N = the number of subjects in the group, baseline (column 3) shows the MLSI score prior to the treatment, week 4 and week 8 show the total MLSI score (covariate adjusted, base-line 3.77) after 4 weeks and 8 weeks of treatment, respectively.

The values with the identical superscript letters are not statistically different, while those with different superscript are different at $p<0.05$ (2-tail test).

Table 3

Whitening agent	N	Baseline	Week 4	Week 8
6.5% CaP_2O_7 + 0.38% $NaHCO_3$	49	3.83 ± 1.32	2.45 ± 0.13^{a}	2.05 ± 0.14^{a}
4.5% $CaCO_3$ + 0.38% $NaHCO_3$	53	3.66 ± 1.28	2.56 ± 0.13^{a}	$2.31 \pm 0.13^{a,b}$
0.38% $NaHCO_3$	52	3.89 ± 1.24	2.71 ± 0.13^{a}	2.46 ± 0.13^{b}
No gum control	54	3.69 ± 1.35	2.65 ± 0.13^{a}	2.45 ± 0.13^{b}

Tables 4 and 5 show the results from the above mentioned clinical trials in per cent of stains removed after 8 weeks of treatment presented for different areas of the teeth. The total (column 3) shows the total removal of stains whereas the remaining columns specify the percentage of removed stain on specific teeth areas. The stain reduction scores for the chewing gum groups were calculated vs. the no gum control group.

* = statistically different from the control group at $p<0.05$. Number of subjects (N) in each group as above.

Table 4

% Reduction in stain

Whitening agent	N	Total	Maxilla	Mandible	Facial	Lingual	Marginal	Body	Proximal
6.5% CaP_2O_7 + 0.38% $NaHCO_3$	49	16*	26*	12	17	16*	11	29*	16*
4.5% $CaCO_3$ + 0.38% $NaHCO_3$	53	6	17	0	4	6	6	7	5
0.38% $NaHCO_3$	52	0	2	-2	1	-1	-8	1	1
No gum control	54	---	---	---	---	---	---	---	---

Table 5

% Reduction in stain

Whitening agent	N	Total	Maxilla/ Facial	Mandible/ Facial	Maxilla/ Lingual	Mandible/ Lingual
6.5% CaP_2O_7 + 0.38% $NaHCO_3$	49	16*	36*	11	22*	11
4.5% $CaCO_3$ + 0.38% $NaHCO_3$	53	6	22	-4	13	3
0.38% $NaHCO_3$	52	0	19	-6	-5	2
No gum control	54	---	---	---	---	---

Table 6 shows the results from the above mentioned clinical trials on the effect of tooth whitening chewing gum on the stain removal from the teeth of smokers in total MLSI scores (covariate adjusted, baseline = 3.86).

Table 6

Whitening agent	N	Baseline	Week 4	Week 8
6.5% CaP_2O_7 + 0.38% $NaHCO_3$	11	4.06 ± 1.22	2.71 ± 0.33[a]	2.01 ± 0.34[a]
4.5% $CaCO_3$ + 0.38% $NaHCO_3$	11	3.95 ± 0.98	2.89 ± 0.33[a]	2.63 ± 0.34[a,b]
0.38% $NaHCO_3$	17	3.85 ± 1.18	3.12 ± 0.26[a]	3.09 ± 0.27[b]
No gum control	15	3.65 ± 1.43	2.73 ± 0.28[a]	2.52 ± 0.29[a,b]

Example 4

Two standard chewing gum compositions containing 1.61 g Ca/100 g and 1.27 g Ca/100 g in the form of calcium carbonate and calcium pyrophosphate, respectively, were assayed for the degree of release of their calcium source upon chewing. These concentrations are by weight of the core excluding any coating, approximately 4.5% of calcium carbonate and 6.5% of calcium pyrophosphate.

2 test persons each chewed one piece of chewing gum containing calcium carbonate and one piece of chewing gum containing calcium pyrophosphate for 0, 5, 10, and 20 minutes, respectively. The amount of calcium in the gum residue was determined by extraction in a binary mixture of chloroform and 1% hydrochloric acid (HCl) water phase. The water phase was subsequently analyzed by atomic absorption spectroscopy (AAS). The release percentage was calculated as:

$$\% \text{ Release} = 100\% - C_T * 100\% / C_{T0}$$

Where C_T = concentration to time T minutes, and C_{T0} = concentration to time $T_0 = 0$ minutes.

The result is shown in Fig. 1. It is shown that within 5 minutes more than 80% of calcium pyrophosphate is released from the composition whereas less than 20% of calcium carbonate is released after more than 15 min. of chewing the two otherwise identical chewing gum compositions.

Example 5

This non-limiting example discloses the inventive composition formulated as a confectionary composition, wherein the sweeteners constitute the confectionary base.

The composition is based on a standard confectionary composition in addition to the specified tooth whitening agent comprising calcium pyrophosphate. The standard confectionary composition used herein consists essentially of the following ingredients:

Sweeteners	97.49%
High intensity sweeteners	0.13%
Flavours	0.18%
Sodium bicarbonate	0.12%
Calcium pyrophosphate	2.08%